

Pseudoslit Spectrometer

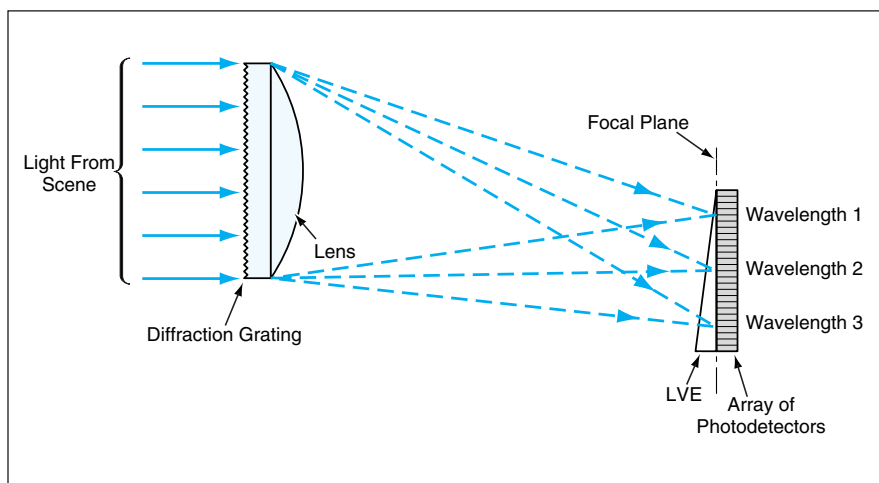
Functioning similarly to a slit spectrometer, this instrument would be optomechanically simpler.

Goddard Space Flight Center, Greenbelt, Maryland

The pseudoslit spectrometer is a conceptual optoelectronic instrument that would offer some of the advantages, without the disadvantages, of prior linear-variable etalon (LVE) spectrometers and prior slit spectrometers. The pseudoslit spectrometer is so named because it would not include a slit, but the combined effects of its optical components would include a spatial filtering effect approximately equivalent to that of a slit.

Like a prior LVE spectrometer, the pseudoslit spectrometer would include an LVE (essentially, a wedgelike narrow-band-pass filter, the pass wavelength of which varies linearly with position in one dimension) in a focal plane covering an imaging planar array of photodetectors. However, the pseudoslit spectrometer would be more efficient because unlike a prior LVE spectrometer, the pseudoslit spectrometer would not have to be scanned across an entire field of view to obtain the spectrum of an object of interest that may occupy only a small portion of the field of view. Like a prior slit spectrometer, the pseudoslit spectrometer could acquire the entire spectrum of such a small object without need for scanning. However, the pseudoslit spectrometer would be optically and mechanically simpler: it would have fewer components and, hence, would pose less of a problem of alignment of components and would be less vulnerable to misalignment.

The pseudoslit spectrometer would include an input optical component



The LVE would be matched, spatially and spectrally, to the focal-plane spectral dispersion pattern of the diffraction grating.

that would both spectrally disperse the light from the scene under observation and focus the light onto the array of photodetectors. The input optical element could be, for example, concave diffraction grating, a combination of a lens and a prism, or, as shown in the figure, a combination of a lens and a diffraction grating. The LVE would be custom fabricated so that, at the focal plane, its spatial variation of pass wavelength would match the spectral dispersion pattern created by the grating. As a result of this match, the LVE would select the spectrum of only one slitlike strip in the field of view.

Hence, position along one axis of the array (in the case of the figure, the axis perpendicular to the page) would corre-

spond to position along the strip in the scene, whereas position along the other axis (the vertical axis in the figure) would correspond to the wavelength of light. In other words, the pseudoslit spectrometer would measure the spectrum of a narrow strip in the scene. To acquire data to construct a spectral image of the entire scene, one would have to scan the pseudoslit spectrometer to scan the strip across the scene.

This work was done by Dennis C. Reuter and George H. McCabe of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-13806

Waste-Heat-Driven Cooling Using Complex Compound Sorbents

Development of improved sorbents revives a long-neglected heat-pump concept.

Lyndon B. Johnson Space Center, Houston, Texas

Improved complex-compound sorption pumps are undergoing development for use as prime movers in heat-pump systems for cooling and dehumidification of habitats for humans on the Moon and for residential and commercial cooling on Earth. Among the advantages of sorption

heat-pump systems are that they contain no moving parts except for check valves and they can be driven by heat from diverse sources: examples include waste heat from generation of electric power, solar heat, or heat from combustion of natural gas.

The use of complex compound sorbents in cooling cycles is not new in itself: Marketing of residential refrigerators using SrCl_2 was attempted in the 1920s and '30s and was abandoned because heat- and mass-transfer rates of the sorbents were too low. Addressing

the issue that gave rise to the prior abandonment of complex compound sorption heat pumps, the primary accomplishment of the present development program thus far has been the characterization of many candidate sorption media, leading to large increases in achievable heat- and mass-transfer rates. In particular, two complex compounds (called "CC260-1260" and "CC260-2000") were found to be capable of functioning over the temperature range of interest for the lunar-habitat applica-

tion and to offer heat- and mass-transfer rates and a temperature-lift capability adequate for that application.

Regarding the temperature range: A heat pump based on either of these compounds is capable of providing a 95-K lift from a habitable temperature to a heat-rejection (radiator) temperature when driven by waste heat at an input temperature ≥ 500 K. Regarding the heat- and mass-transfer rates or, more precisely, the power densities made possible by these rates: Power densities ob-

served in tests were 0.3 kilowatt of cooling per kilogram of sorbent and 2 kilowatts of heating per kilogram of sorbent. A prototype 1-kilowatt heat pump based on CC260-2000 has been built and demonstrated to function successfully.

This work was done by Uwe Rockefeller, Lance Kirol, and Kaveh Khalili of Rocky Research for Johnson Space Center. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809. MSC-22952

Improved Refractometer for Measuring Temperatures of Drops

The task of upgrading PDPA hardware for measurement of temperature is simplified.

Marshall Space Flight Center, Alabama

The Dual Rainbow refractometer is an enhanced version of the Rainbow refractometer, which is added to, and extends the capabilities of, a phase Doppler particle analyzer (PDPA). A PDPA utilizes pairs of laser beams to measure individual components of velocity and sizes of drops in a spray. The Rainbow-refractometer addition measures the temperatures of individual drops. The designs of prior versions of the Rainbow refractometer have required substantial modifications of PDPA transmitting optics, plus dedicated lasers as sources of illumination separate from, and in addition to, those needed for PDPA measurements. The enhancement embodied in the Dual Rainbow refractometer eliminates the need for a dedicated laser and confers other advantages as described below.

A dedicated laser is no longer needed

because the Dual Rainbow refractometer utilizes one of the pairs of laser beams already present in a PDPA. Hence, the design of the Dual Rainbow refractometer simplifies the task of upgrading PDPA hardware to enable measurement of temperature. Furthermore, in a PDPA/Dual-Rainbow-refractometer system, a single argon-ion laser with three main wavelengths can be used to measure the temperatures, sizes, and all three components of velocity (in contradistinction to only two components of velocity in a prior PDPA/Rainbow-refractometer system).

In order to enable the Dual Rainbow refractometer to utilize a pair of PDPA laser beams, it was necessary to (1) find a location for the refractometer receiver, such that the combined rainbow patterns of two laser beams amount to a pattern identical to that of a single beam, (2) ad-

just the polarization of the two beams to obtain the strongest rainbow pattern, and (3) find a location for the PDPA receiver to obtain a linear relationship between the measured phase shift and drop size.

This work was done by Amir A. Naqwi of Aerometrics/TSI, Inc. for Marshall Space Flight Center. For further information, contact the Company at (651) 490-3836.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to Aerometrics/TSI, Inc.

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Refer to MFS-31531, volume and number of this NASA Tech Briefs issue, and the page number.

Semiconductor Lasers Containing Quantum Wells in Junctions

Additional design degrees of freedom are available for improving performance.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a recent improvement upon $\text{In}_x\text{Ga}_{1-x}\text{As}/\text{InP}$ semiconductor lasers of the bipolar cascade type, quantum wells are added to Esaki tunnel junctions, which are standard parts of such lasers. The energy depths and the geometric locations and thicknesses of the wells are tailored to exploit quantum tunneling such that, as described below, electrical resistances of junctions and concentrations of dopants can be reduced while laser performances can be improved.

$\text{In}_x\text{Ga}_{1-x}\text{As}/\text{InP}$ bipolar cascade lasers have been investigated as sources of near-infrared radiation (specifically, at wavelengths of about 980 and 1,550 nm) for photonic communication systems. The Esaki tunnel junctions in these lasers have been used to connect adjacent cascade stages and to enable transport of charge carriers between them. Typically, large concentrations of both n (electron-donor) and p (electron-ac-

ceptor) dopants have been necessary to impart low electrical resistances to Esaki tunnel junctions. Unfortunately, high doping contributes free-carrier absorption, thereby contributing to optical loss and thereby, further, degrading laser performance.

In accordance with the present innovation, quantum wells are incorporated into the Esaki tunnel junctions so that the effective heights of barriers to quantum tunneling are reduced (see figure).